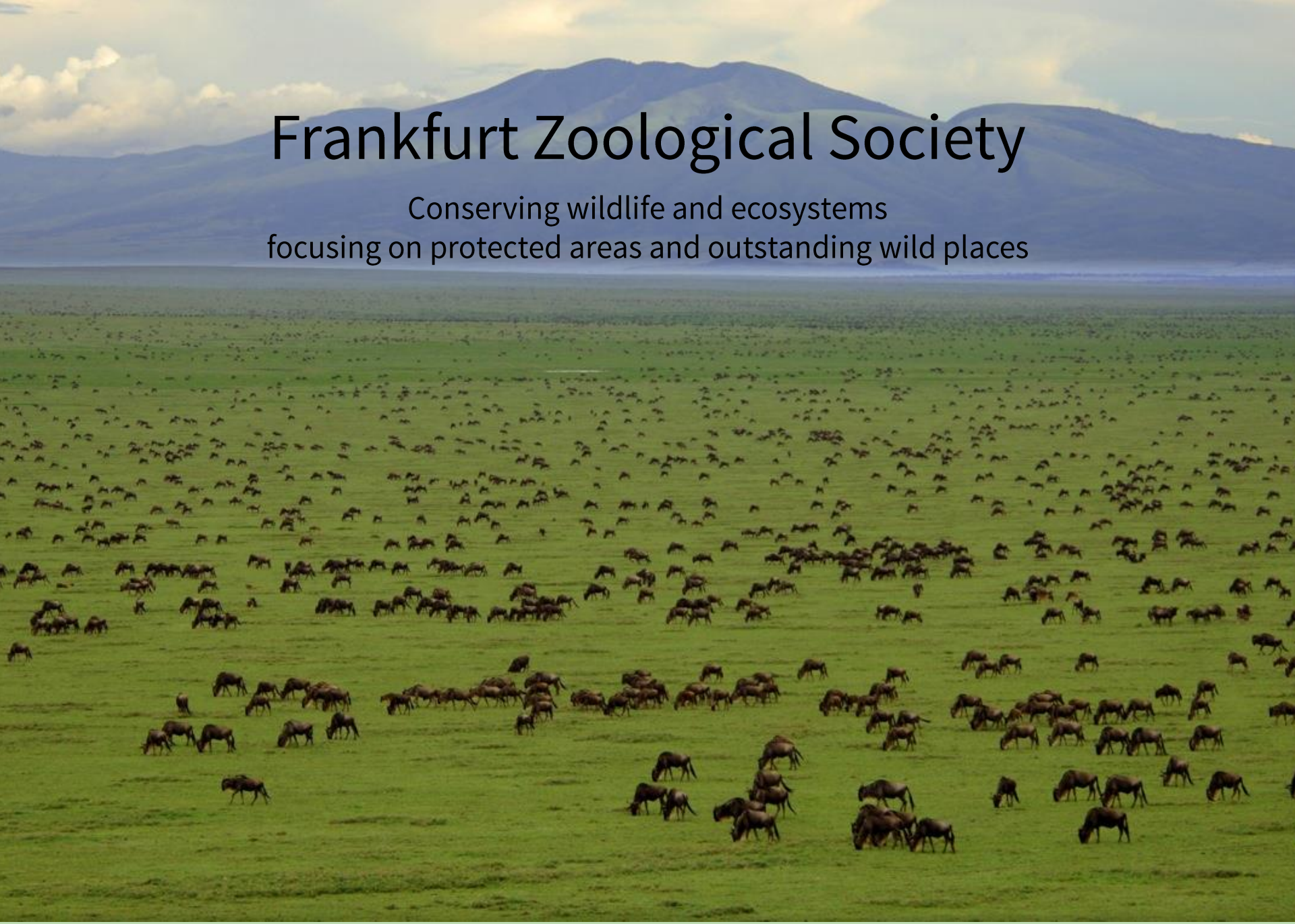


Frankfurt Zoological Society

Conserving wildlife and ecosystems
focusing on protected areas and outstanding wild places

Sexual Selection, Temperature, and the Lion's Mane

Peyton M. West* and Craig Packer

The mane of the African lion (*Panthera leo*) is a highly variable trait that reflects male condition and ambient temperature. We examined the consequences of this variation in a long-term study of lions in the Serengeti National Park, Tanzania. Mane darkness indicates nutrition and testosterone and influences both female choice and male-male competition. Mane length signals fighting success and only appears to influence male-male assessment. Dark-maned males enjoy longer reproductive life-spans and higher offspring survival, but they suffer higher surface temperatures, abnormal sperm, and lower food intake during hot months of the year. Maned males are hotter than females, and males have lighter and/or shorter manes in hotter seasons, years, and habitats. This phenotypic plasticity suggests that the mane will respond to forecasted increases in ambient temperature.

Sexually selected indicator traits reflect male health and vigor (*1*), revealing how well individuals withstand environmental stress (*2*, *3*). Environmental effects on trait morphology can be substantial (*4*, *5*), outweighing both genetic effects (*6*) and reproductive advantages (*7*). Changing environmental conditions can alter trait costs, leading to the evolutionary loss of sexual ornaments (*8*) or possibly even to species extinction (*9*). The global environment is undergoing rapid change due to anthropogenic disturbance (*10*), and these changes have already altered some sexually selected behavior (*11*, *12*). Sexually selected morphological traits may also be vulnerable, depending on the relative importance of ecological effects, reproductive benefits, and a trait's phenotypic and/or genetic plasticity, as well as the magnitude of environmental change.

Here we examine the evolutionary and ecological factors influencing the mane of the African lion. Manes are sexually dimorphic, develop at puberty, and are highly variable; thus, the mane has long been considered a sexually selected trait (*13*). Mane size and darkness are reduced in populations and subspecies living in hot climates [see supporting

Department of Ecology, Evolution and Behavior, University of Minnesota, 1987 Upper Buford Circle, St. Paul, MN 55108, USA.

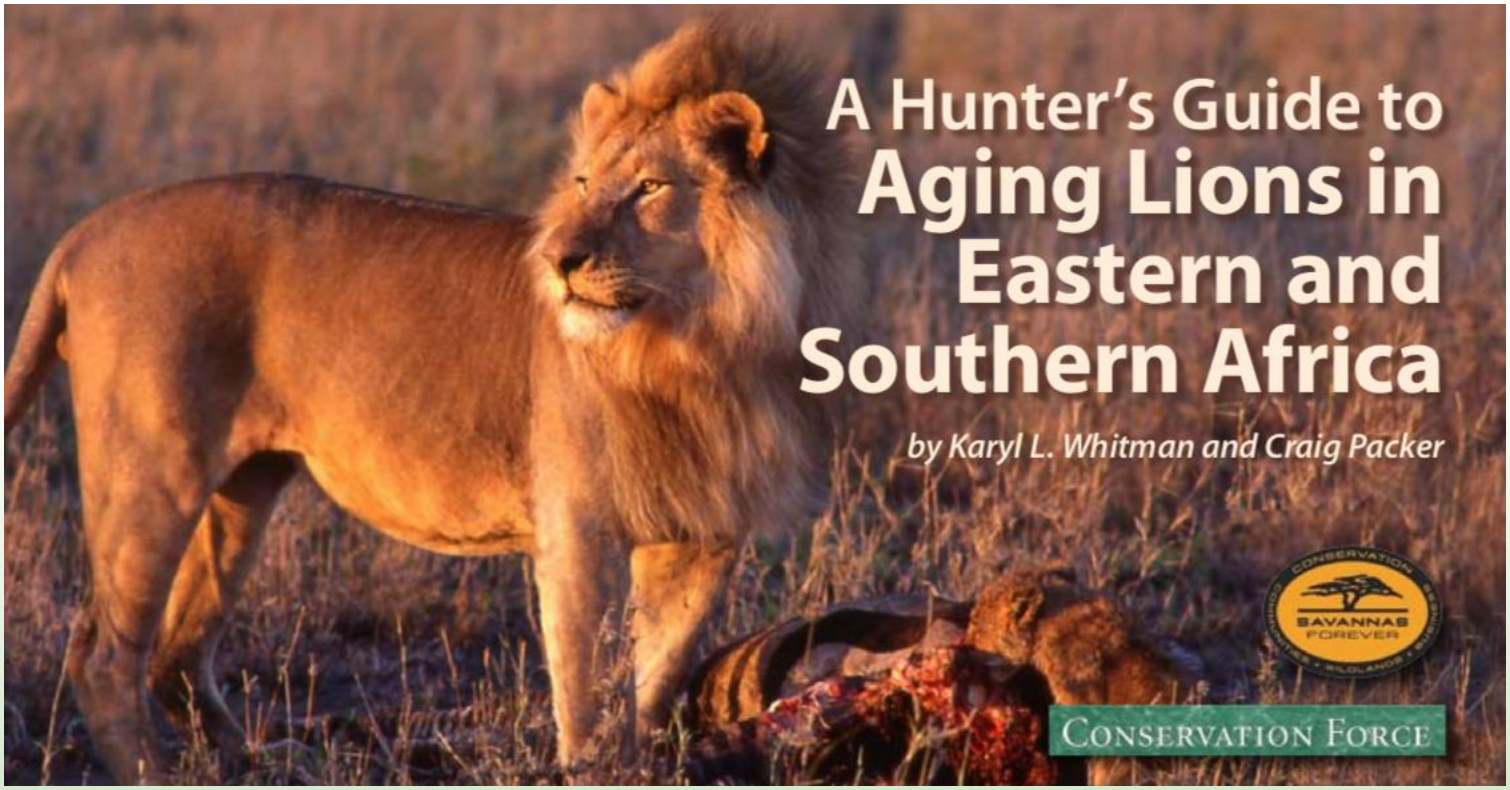
*To whom correspondence should be addressed. E-mail: west0302@umn.edu

Sustainable trophy hunting of African lions

Karyl Whitman, Anthony M. Starfield, Henley S. Quadling & Craig Packer

Department of Ecology, Evolution and Behavior, University of Minnesota, 1987 Upper Buford Circle, Saint Paul, Minnesota 55108, USA

In most species, sport hunting of male trophy animals can only reduce overall population size when the rate of removal of males is so high that females can no longer be impregnated[1]. However, where males provide extensive paternal care, the removal of even a few individuals could harm the population as a whole[2,3]. In species such as lions, excessive trophy hunting could theoretically cause male replacements (and associated infanticide[4,5]) to become sufficiently common to prevent cubs reaching adulthood. Here we simulate the population consequences of lion trophy hunting using a spatially explicit, individual-based, stochastic model parameterized with 40 years of demographic data from northern Tanzania. Although our simulations confirm that infanticide increases the risk of population extinction, trophy hunting could be sustained simply by hunting males above a minimum age threshold, and this strategy maximizes both the


A Hunter's Guide to
Aging Lions in
Eastern and
Southern Africa
by Karyl L. Whitman and Craig Packer
SAVANNAS FOREVER
CONSERVATION FORCE

1	About FZS
2	The Biodiversity Crisis
3	Protected Areas and Buffer Zones in Africa
4	Perspective from the Ground
5	Moving Forward

Serengeti Shall Not Die

FZS is one of Germany's oldest conservation organizations, active for more than 50 years in Serengeti and beyond

How FZS works

- Biodiversity and wilderness
- Protected areas
- Partnerships
- Resource protection
- Community engagement

Practical
Long-term
On the ground

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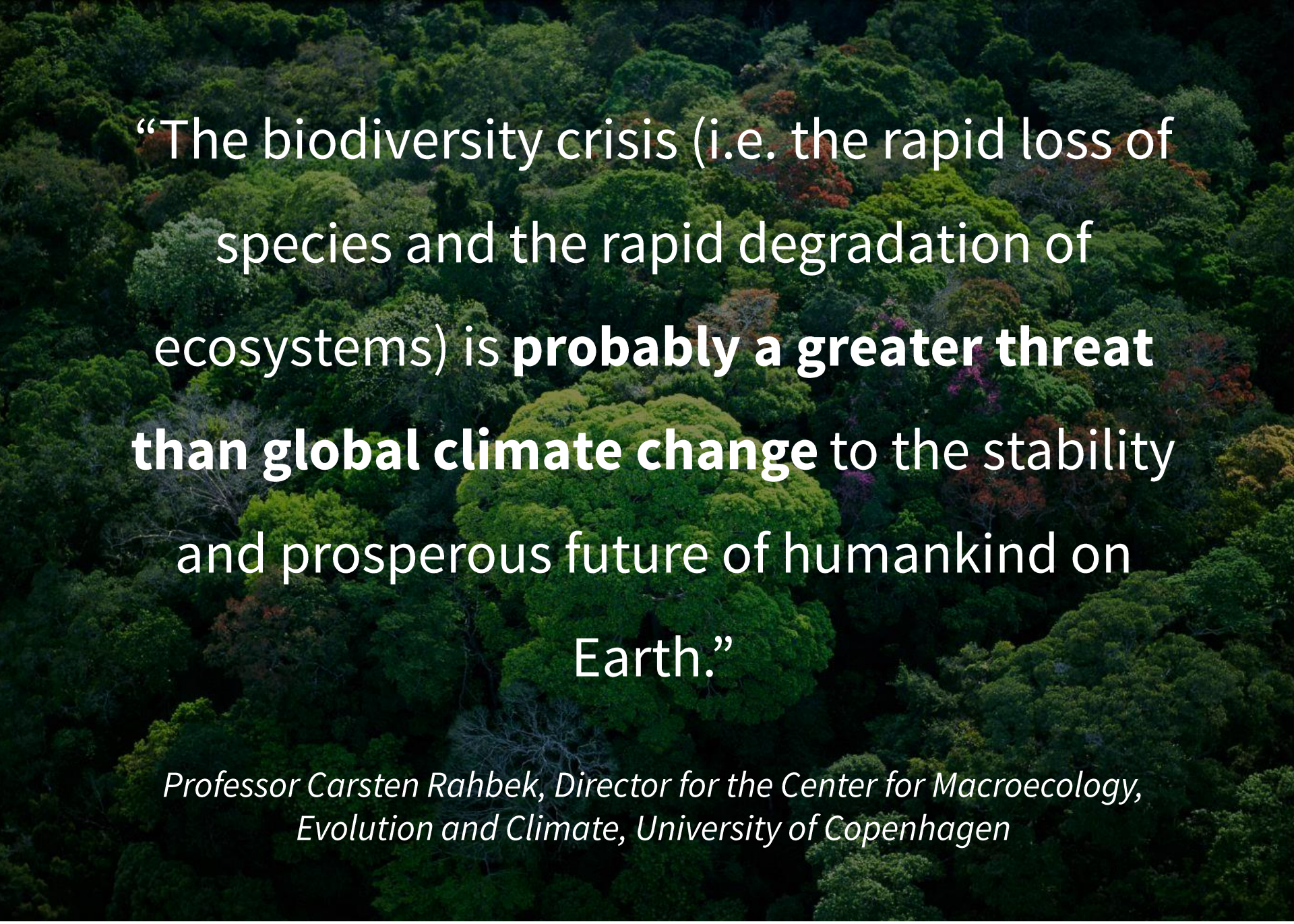
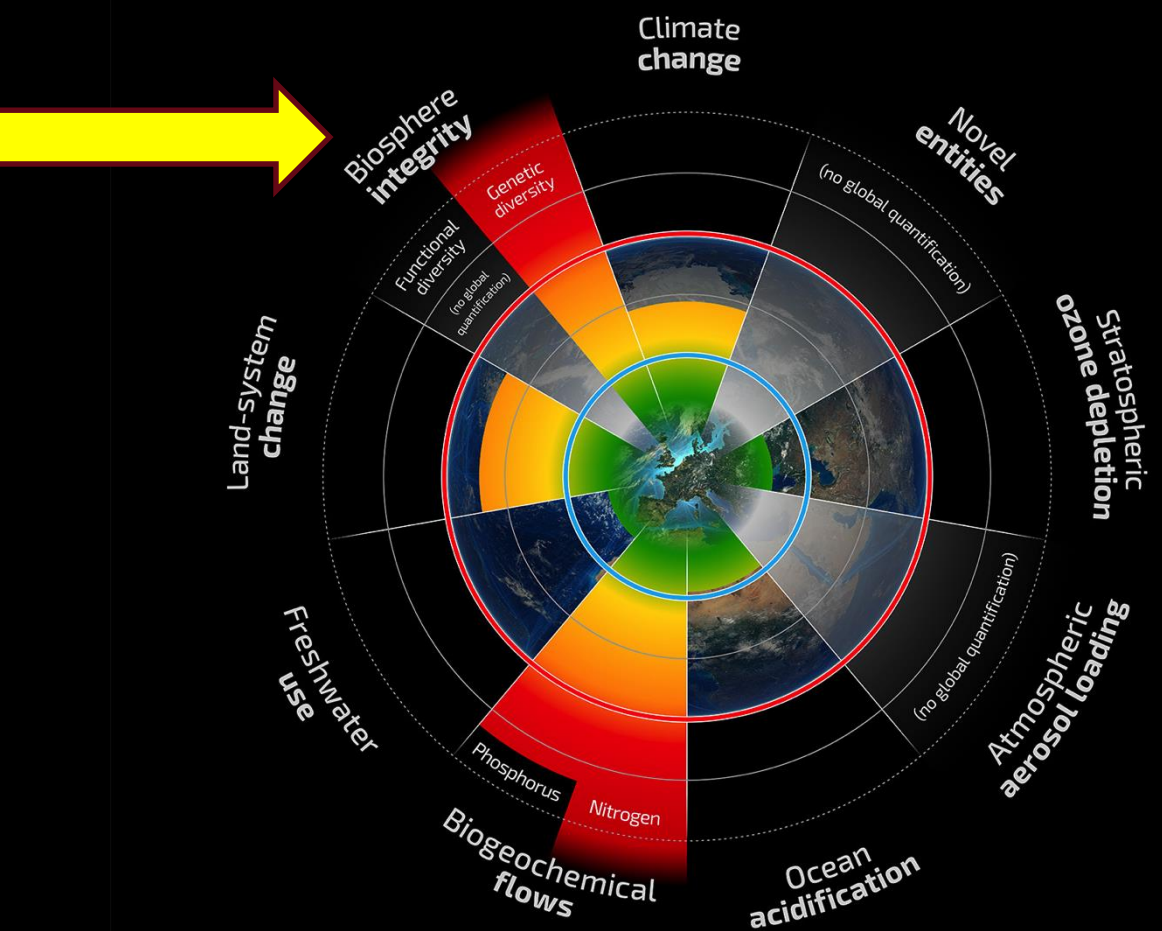

“The biodiversity crisis (i.e. the rapid loss of species and the rapid degradation of ecosystems) is **probably a greater threat than global climate change** to the stability and prosperous future of humankind on Earth.”
Professor Carsten Rahbek, Director for the Center for Macroecology, Evolution and Climate, University of Copenhagen

Planetary Boundaries

A safe operating space for humanity



Red

Beyond zone of uncertainty (high risk)

Yellow

In zone of uncertainty (increasing risk)

Green

Below boundary (safe)

Source: Steffen et al. Planetary Boundaries: Guiding human development on a changing planet, *Science*, 16 January 2015.
Design: Globaïa

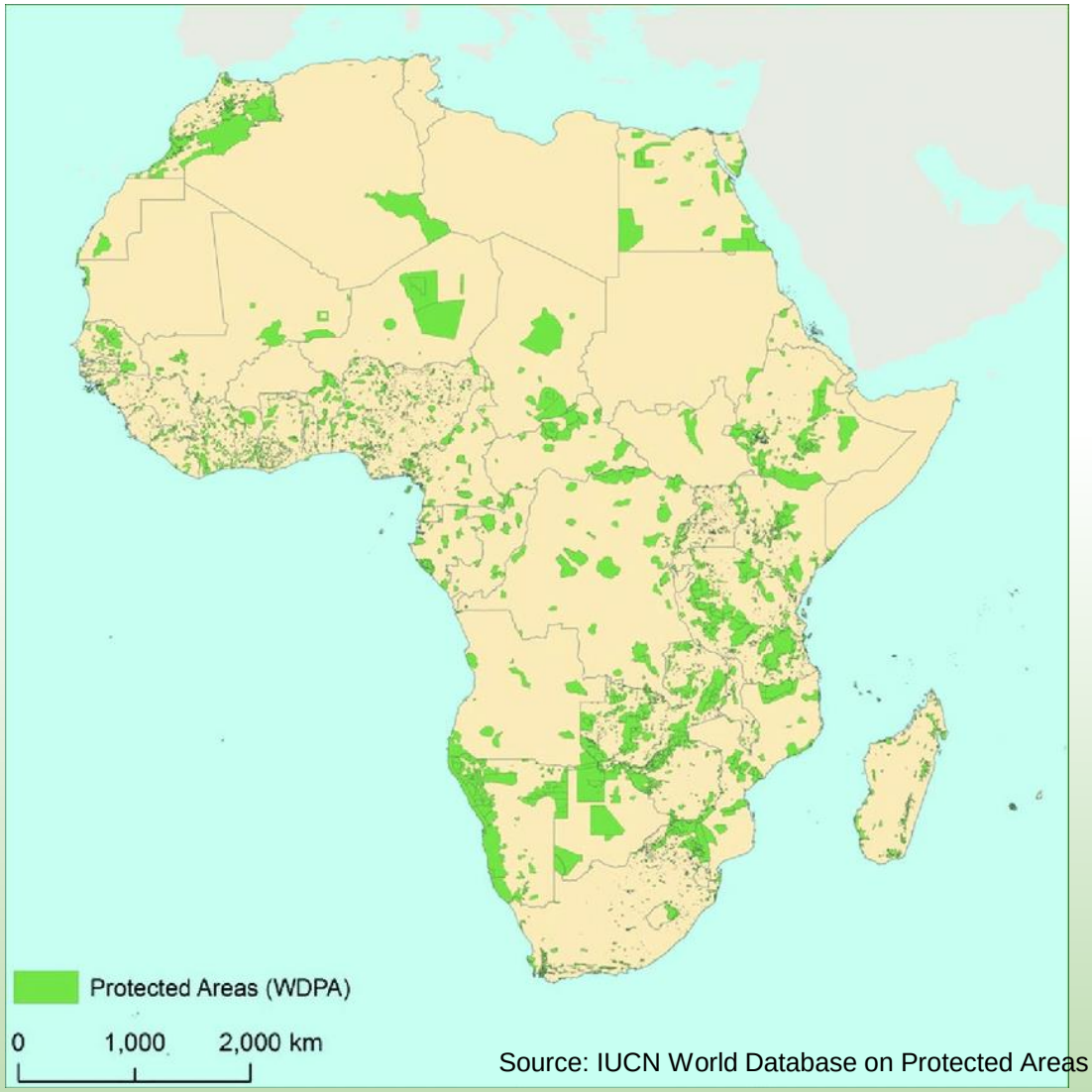
“The main factor currently driving biodiversity loss is habitat destruction.”

- Harvard University Center for Health and Global Environment

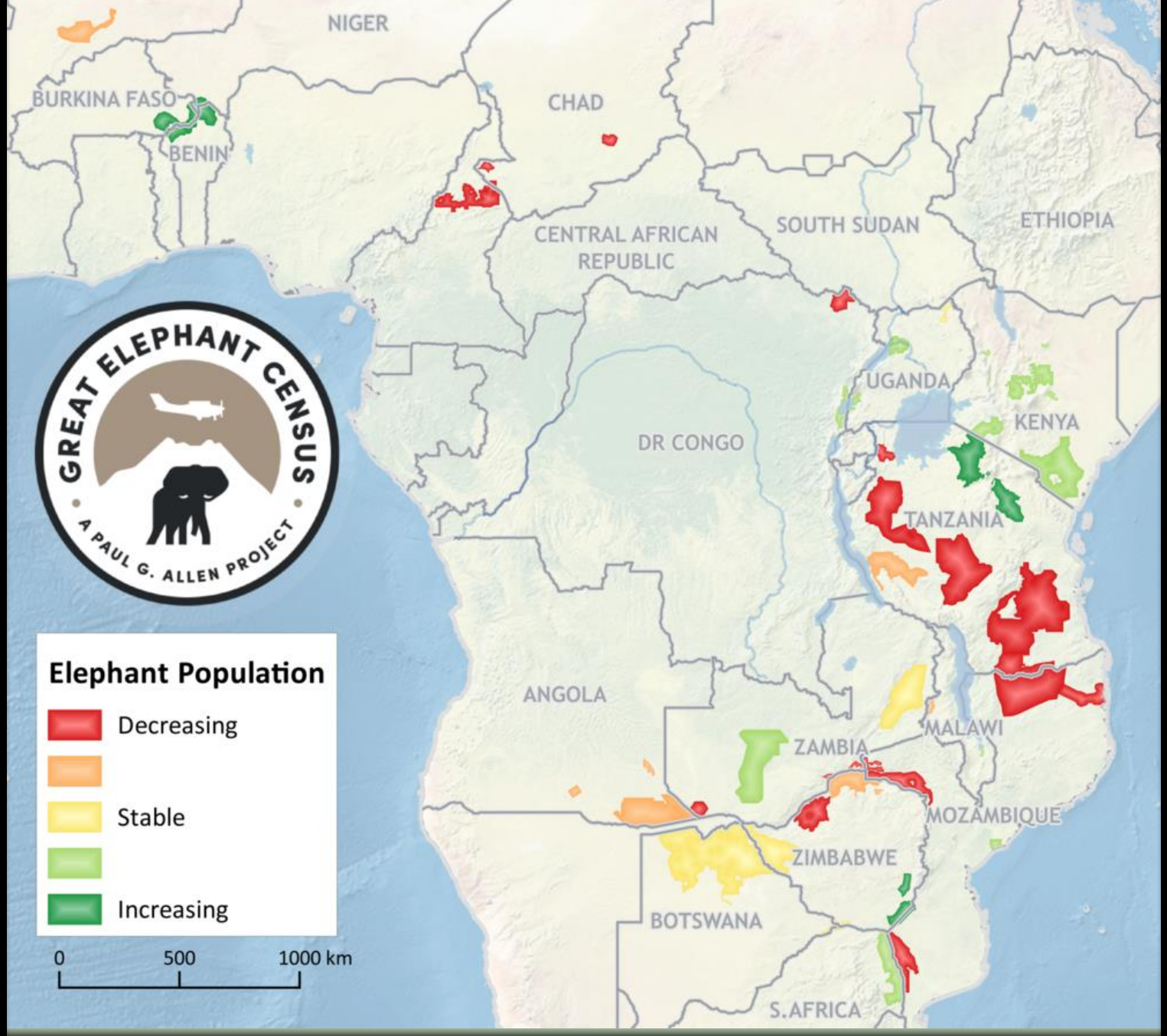
Source: Threats to Biodiversity and Ecosystems; Palm Oil Co, 2016

Source: Chape S, Harrison J, Spalding M, Lysenko I (2005) Measuring the extent and effectiveness of areas as an indicator for meeting global biodiversity targets. Philos Trans R Soc Lond, B 360:443–455.

Protected areas in Africa



Source: IUCN World Database on Protected Areas


NIGER
BURKINA FASO
BENIN
CHAD
CENTRAL AFRICAN REPUBLIC
SOUTH SUDAN
ETHIOPIA
UGANDA
KENYA
DR CONGO
TANZANIA
ANGOLA
MALAWI
ZAMBIA
MOZAMBIQUE
ZIMBABWE
BOTSWANA
S.AFRICA
GREAT ELEPHANT CENSUS
A PAUL G. ALLEN PROJECT
Elephant Population
Decreasing
Stable
Increasing
0
500
1000 km

Threats to African Protected Areas

Buffer zone:

- An area peripheral to a national park or equivalent reserve, where restrictions are placed upon resource use or special development measures are undertaken to enhance the conservation values of the area.
- **A gradient of protection around the core site**

Source: UNEP-WCMC 2014, Biodiversity A-Z website: www.biodiversitya-z.org, UNEP-WCMC, Cambridge, UK.

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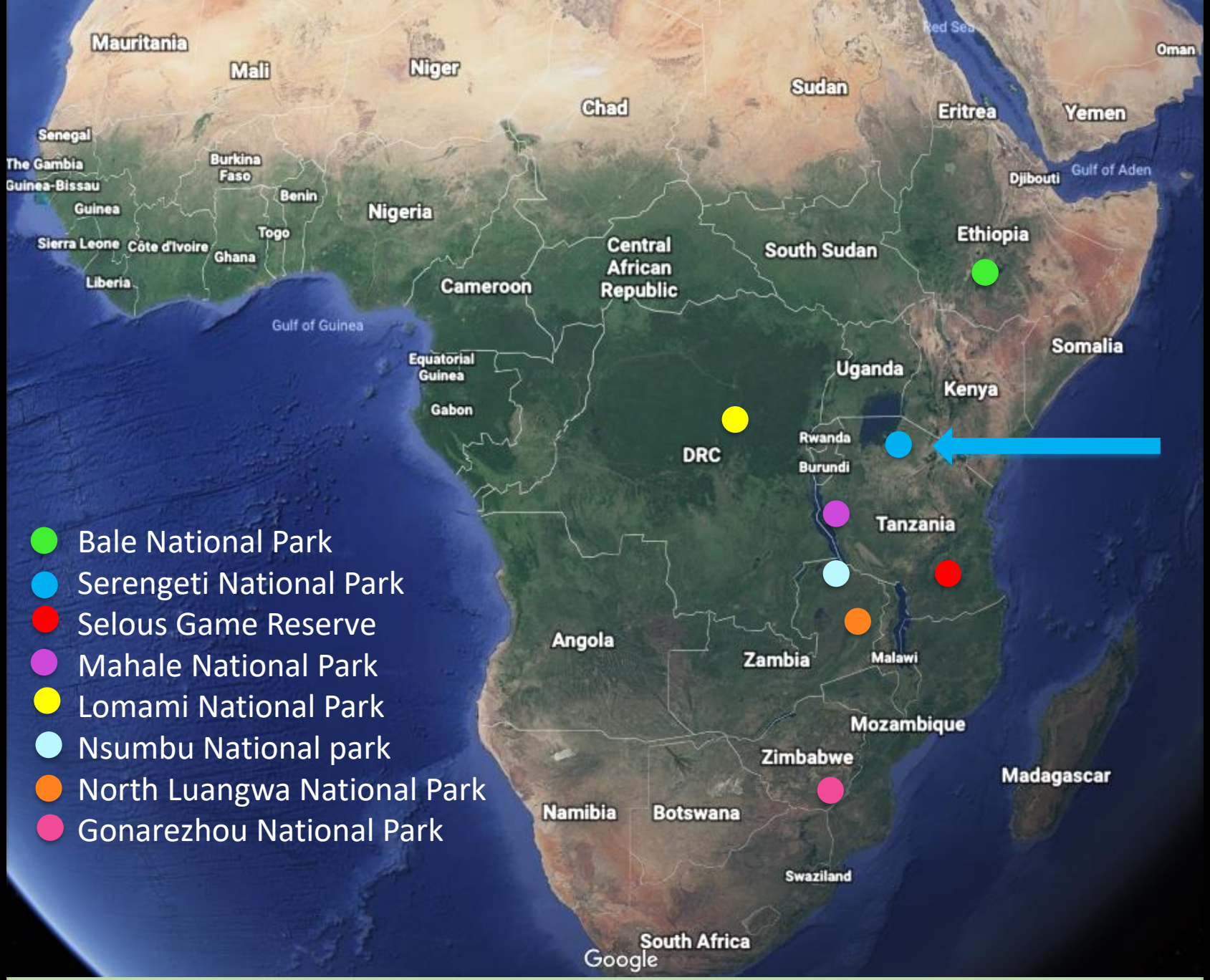
Mauritania
Mali
Niger
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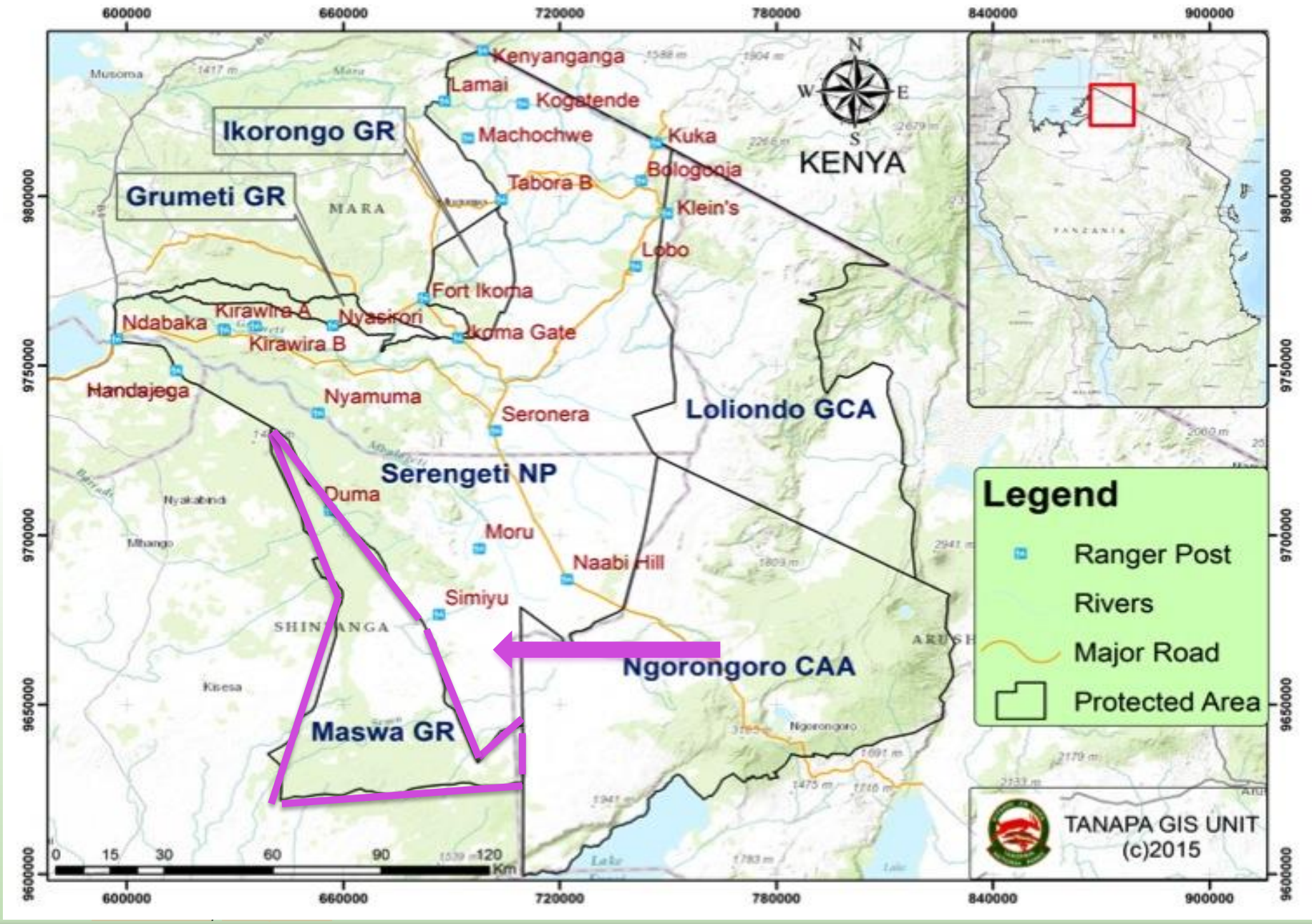
Eritrea
Yemen
Djibouti
Gulf of Aden
Senegal
The Gambia
Guinea-Bissau
Guinea
Burkina Faso
Benin
Nigeria
Togo
Sierra Leone
Côte d'Ivoire
Ghana
Liberia
Gulf of Guinea
Cameroon
Central African Republic
South Sudan
Ethiopia
Somalia
Equatorial Guinea
Gabon
Uganda
Kenya
DRC
Rwanda
Burundi
Tanzania
Angola
Zambia
Malawi
Mozambique
Zimbabwe
Madagascar
Namibia
Botswana
Swaziland
South Africa
Google
Bale National Park
Serengeti National Park
Selous Game Reserve
Mahale National Park
Lomami National Park
Nsumbu National park
North Luangwa National Park
Gonarezhou National Park

Serengeti National Park, Tanzania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Kenyanganga
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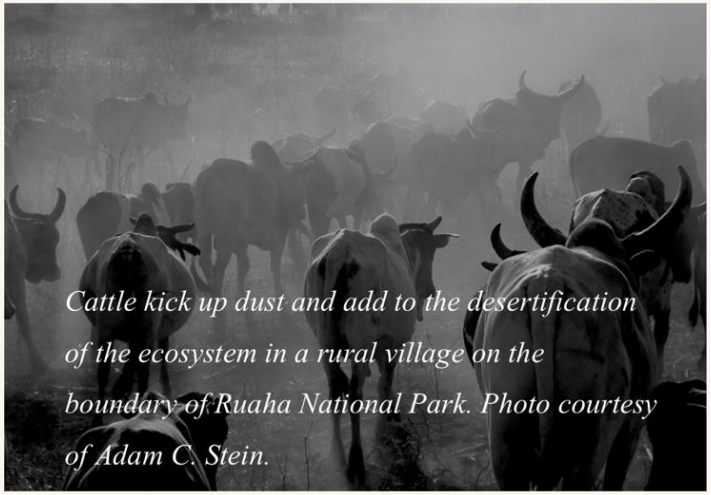
Kogatende
Machochwe
Kuka
Bologonja
Tabora B
Klein's
Lobo
Fort Ikoma
Ikoma Gate
Kirawira A
Nyasirori
Kirawira B
Ndabaka
Handajega
Nyamuma
Seronera
Duma
Moru
Naabi Hill
Simiyu
Ikorongo GR
Grumeti GR
Serengeti NP
Loliondo GCA
Ngorongoro CAA
Maswa GR
MARA
SHINYANGA
KENYA
N
S
W
E
Legend
Ranger Post
Rivers
Major Road
Protected Area
TANAPA GIS UNIT
(c)2015
0 15 30 60 90 120
Km

The Revelator
Wild, Incisive, Fearless.



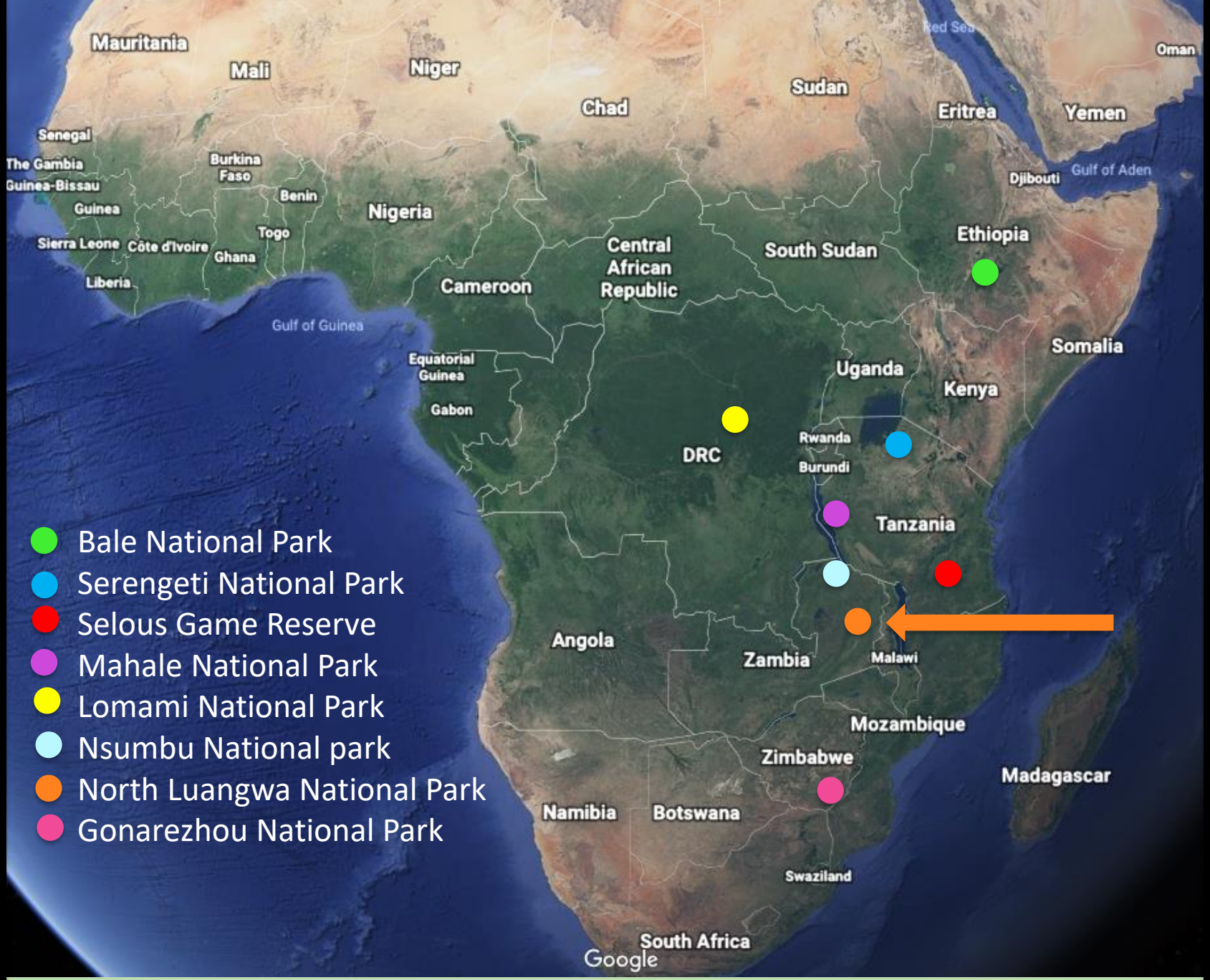
Cattle kick up dust and add to the desertification of the ecosystem in a rural village on the boundary of Ruaha National Park. Photo courtesy of Adam C. Stein.

Tanzania Prepares to Hand Wildlife Reserves Over to Farmers and Livestock

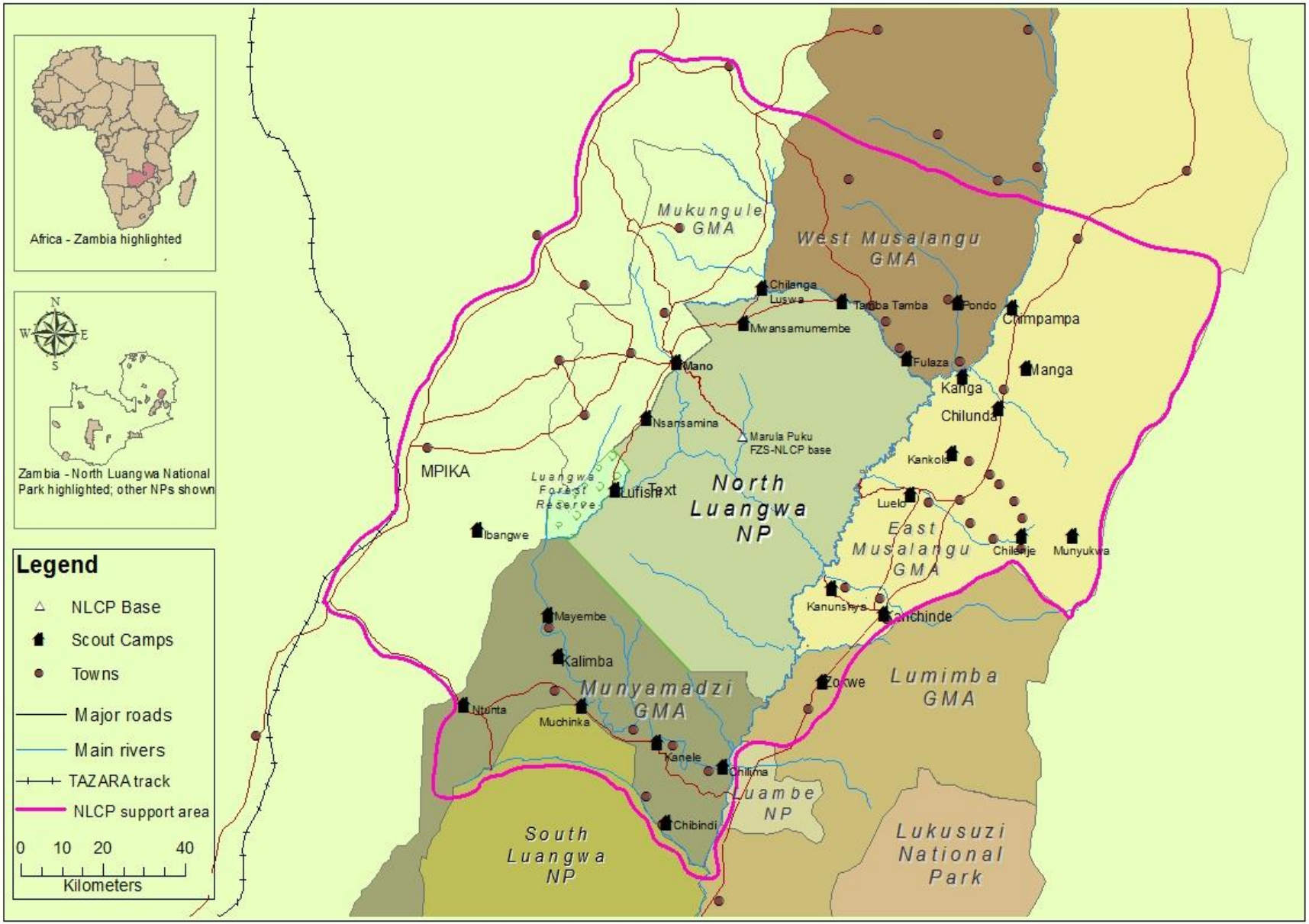
TANZANIA: Five game reserves officially transformed into national parks

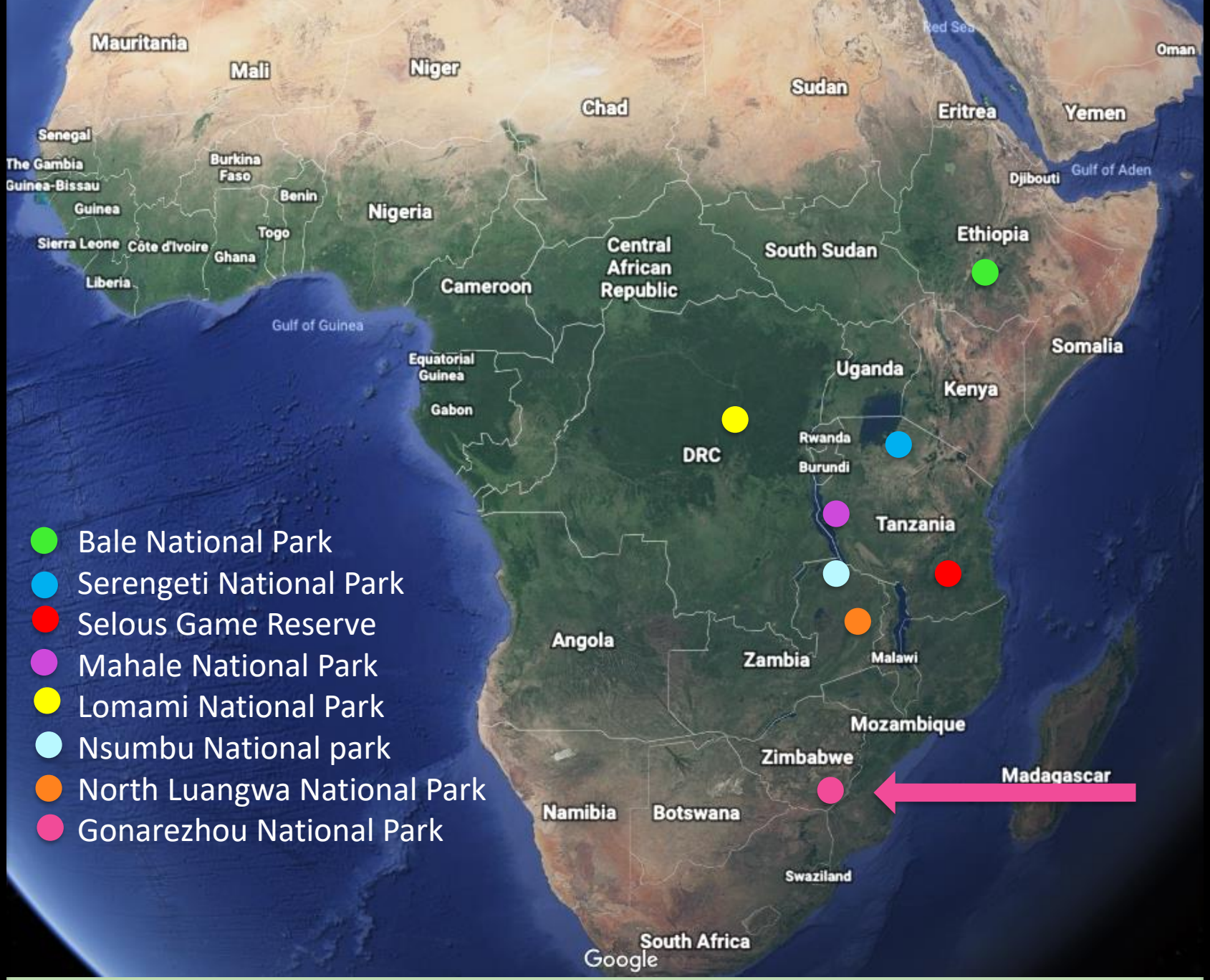
By **Jean Marie Takouleu** - Published on February 28 2019 / Modified on February 28 2019

The Tanzanian government's plan to transform five game reserves into national parks was recently unanimously approved by parliament. Biharamuro, Burigi, Kimisi, Ibanda and Rumanyika thus become national parks.

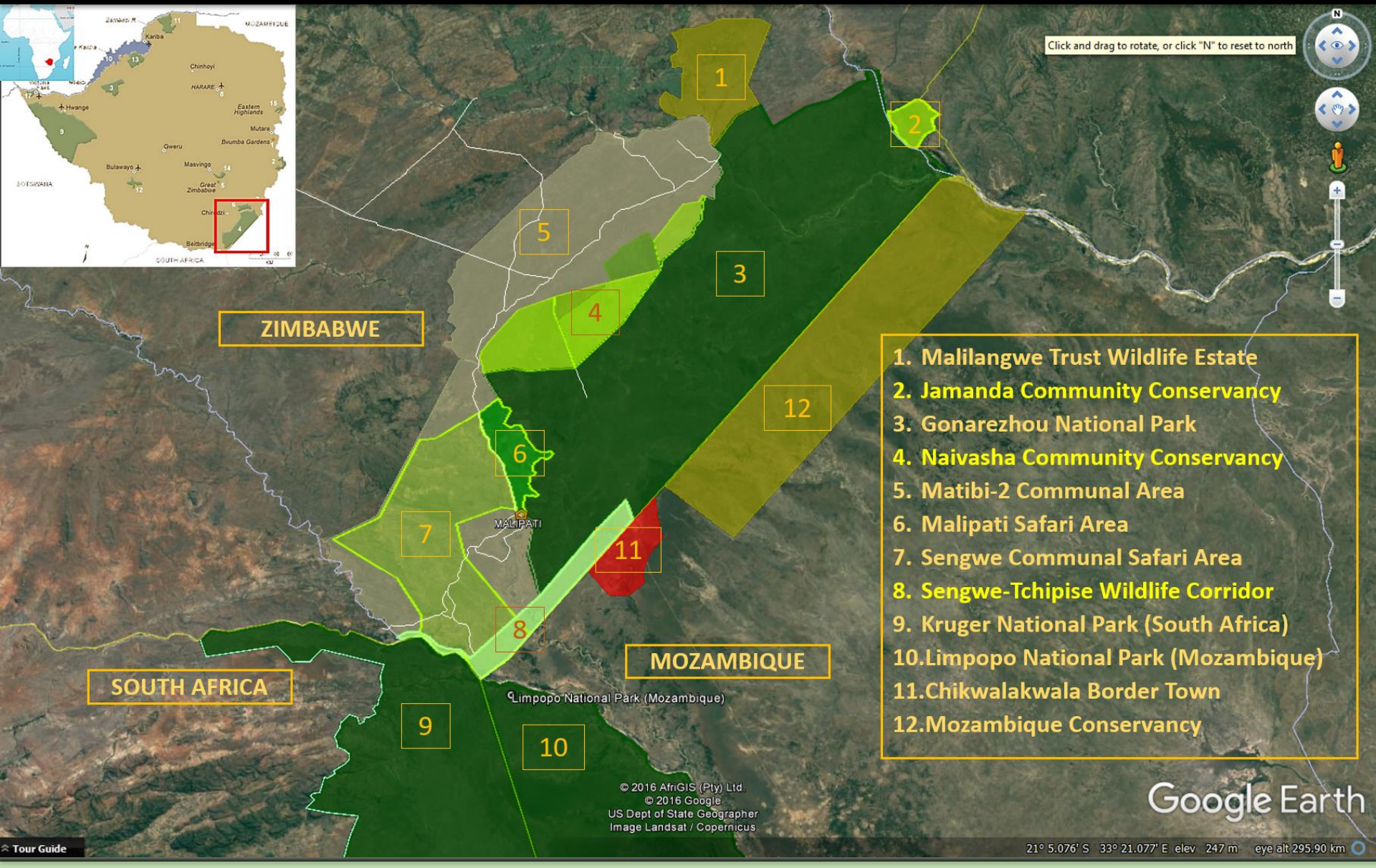

Mauritania
Mali
Niger
Chad
Sudan
Eritrea
Yemen
Oman
Red Sea
Gulf of Aden
Djibouti
Senegal
The Gambia
Guinea-Bissau
Guinea
Sierra Leone
Liberia
Côte d'Ivoire
Ghana
Togo
Benin
Burkina Faso
Nigeria
Cameroon
Central African Republic
South Sudan
Ethiopia
Somalia
Gulf of Guinea
Equatorial Guinea
Gabon
DRC
Uganda
Kenya
Rwanda
Burundi
Tanzania
Angola
Zambia
Malawi
Mozambique
Zimbabwe
Madagascar
Namibia
Botswana
Swaziland
South Africa
Google
Bale National Park
Serengeti National Park
Selous Game Reserve
Mahale National Park
Lomami National Park
Nsumbu National park
North Luangwa National Park
Gonarezhou National Park

North Luangwa National Park, Zambia

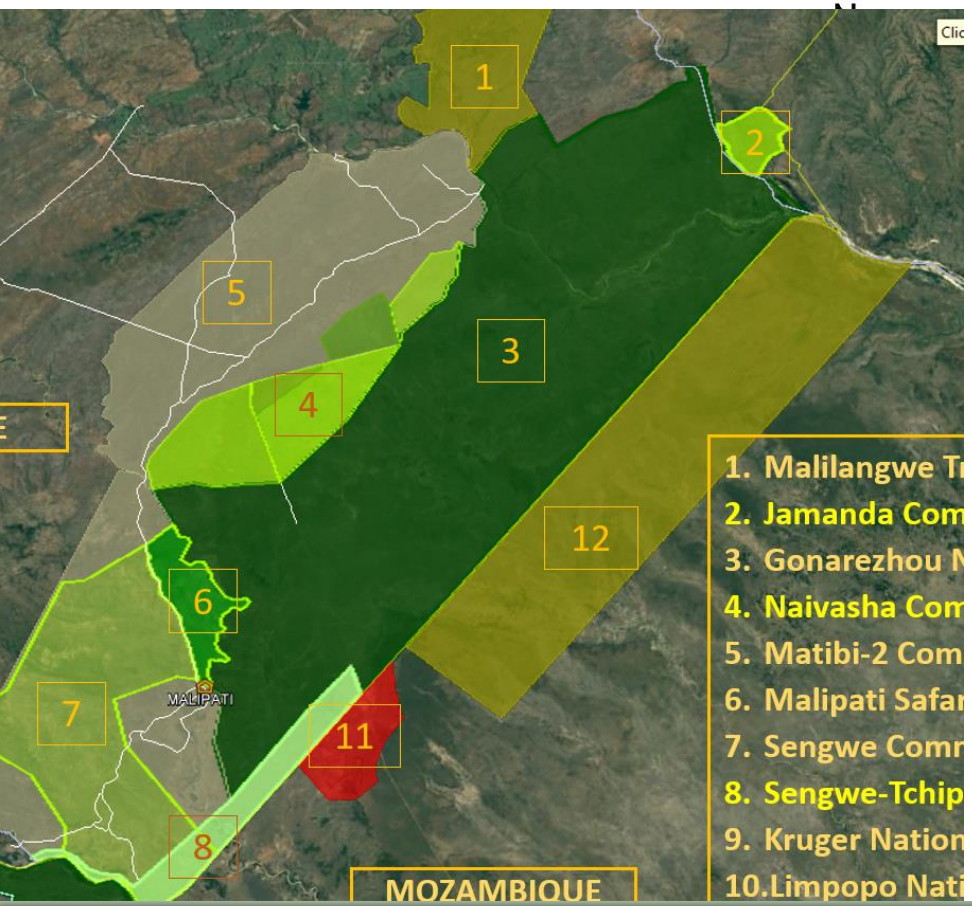

Africa - Zambia highlighted
Zambia - North Luangwa National Park highlighted; other NPs shown
Legend
NLCP Base
Scout Camps
Towns
Major roads
Main rivers
TAZARA track
NLCP support area
0 10 20 40
Kilometers
Mukungule GMA
West Musalangu GMA
Chilanga
Luswa
Tamba Tamba
Pondo
Chimpampa
Mwansamumembe
Mano
Fulaza
Manga
Kanga
Chilunda
Nsansamina
Marula Puku
FZS-NLCP base
Kankoli
MPIKA
Luangwa Forest Reserve
Lufish
Text
North Luangwa NP
Lueli
East Musalangu GMA
Ibangwe
Chilenje
Munyukwa
Kanunshya
Chinchinde
Mayembe
Kalimba
Munyamadzi GMA
Zokwe
Lumimba GMA
Ntunta
Muchinka
Kanele
Chilima
uambe NP
Chibindi
South Luangwa NP
Lukusuzi National Park

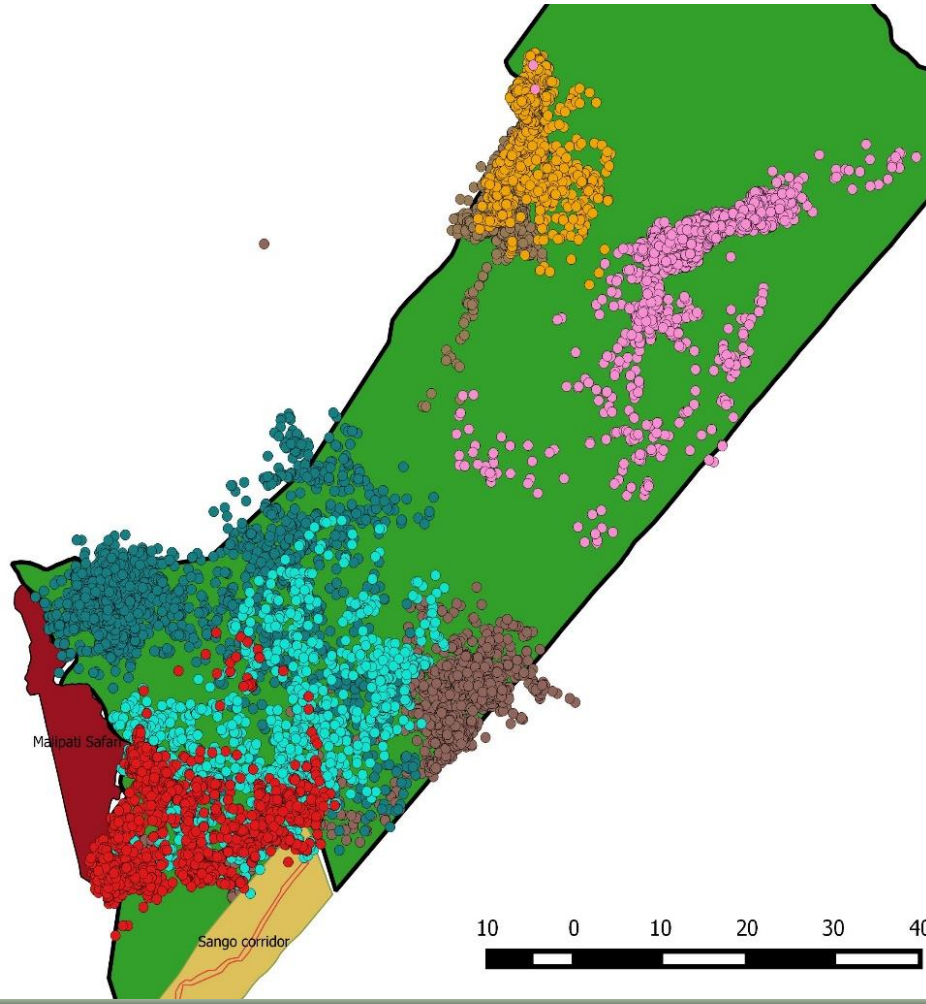

Mauritania
Mali
Niger
Chad
Sudan
Red Sea
Oman
Eritrea
Yemen
Senegal
The Gambia
Guinea-Bissau
Guinea
Burkina Faso
Benin
Nigeria
Togo
Sierra Leone
Côte d'Ivoire
Ghana
Liberia
Gulf of Guinea
Cameroon
Central African Republic
South Sudan
Djibouti
Gulf of Aden
Ethiopia
Somalia
Equatorial Guinea
Gabon
Uganda
Kenya
DRC
Rwanda
Burundi
Tanzania
Angola
Zambia
Malawi
Mozambique
Zimbabwe
Madagascar
Namibia
Botswana
Swaziland
South Africa
Google
Bale National Park
Serengeti National Park
Selous Game Reserve
Mahale National Park
Lomami National Park
Nsumbu National park
North Luangwa National Park
Gonarezhou National Park

Gonarezhou National Park, Zimbabwe


ZIMBABWE
MOZAMBIQUE
SOUTH AFRICA
MALIPATI
Limpopo National Park (Mozambique)
1
2
3
4
5
6
7
8
9
10
11
12
1. Malilangwe Trust Wildlife Estate
2. Jamanda Community Conservancy
3. Gonarezhou National Park
4. Naivasha Community Conservancy
5. Matibi-2 Communal Area
6. Malipati Safari Area
7. Sengwe Communal Safari Area
8. Sengwe-Tchipise Wildlife Corridor
9. Kruger National Park (South Africa)
10. Limpopo National Park (Mozambique)
11. Chikwalakwala Border Town
12. Mozambique Conservancy
Click and drag to rotate, or click "N" to reset to north
© 2016 AfriGIS (Pty) Ltd.
© 2016 Google
US Dept of State Geographer
Image Landsat / Copernicus
Google Earth
Tour Guide
21° 5.076' S 33° 21.077' E elev 247 m eye alt 295.90 km

Gonarezhou elephant movement





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Jambo tours
LEOPARD TOURS
LEOPARD TOURS
LEOPARD TOURS

Protected Areas Work

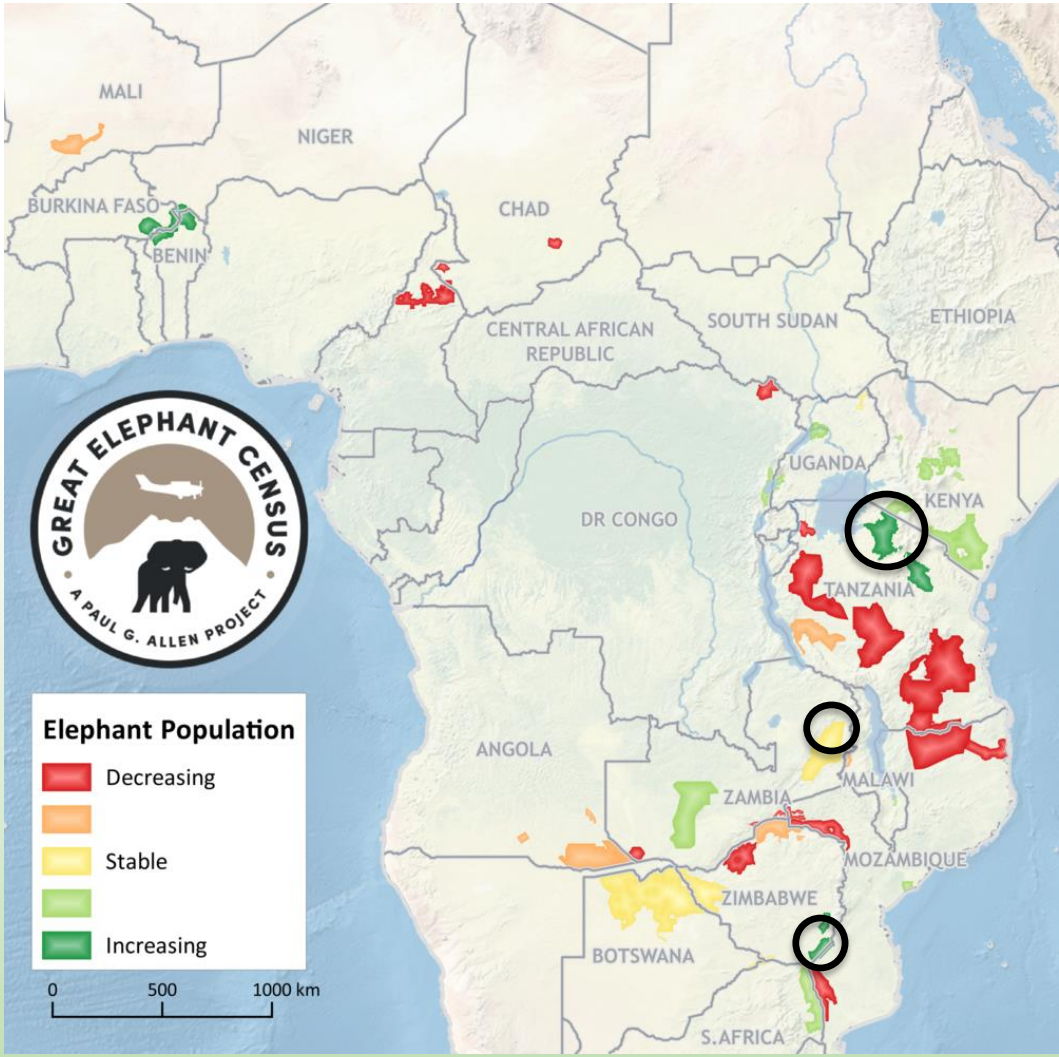
US edition

theguardian

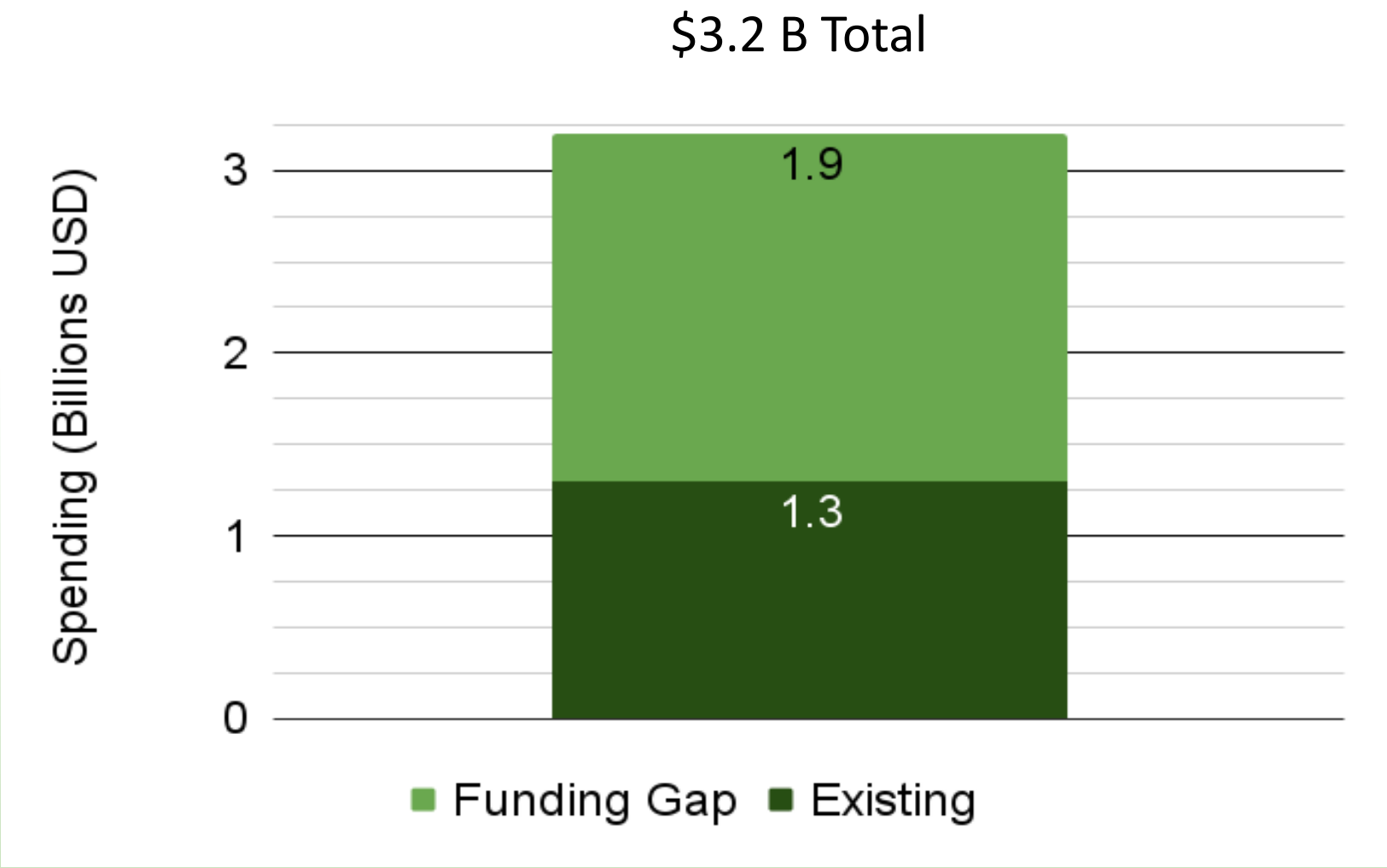
Biodiversity greater inside Earth's protected areas, study finds

Scientists show for the first time that there are 15% more individual plants and animals and 11% more species inside terrestrial conservation zones

A butterfly on a leaf in Yasuni national park, Ecuador, one of the world's biodiversity hotspots. Photograph: Dolores Ochoa/AP



Protected Area Spending Need in Developing Countries



Sources: James et al. *BioScience*, Volume 51, Issue 1, 1 January 2001, Pages 43–52; internal analysis


FRANKFURT
ZOOLOGICAL
SOCIETY
FRANKFURT
ZOOLOGICAL
SOCIETY

“From year to year, the threat of extermination hangs over these wild animals, and it is very unlikely that our children will ever see them as we can see them now—the vast procession of zebras, gazelles and wildebeest moving across the open plains…”

- Alan Morehead, 1960, *Serengeti Shall Not Die*


Thank you